Characterization of microbes intimately associated with the Mars Odyssey Orbiter and its Assembly Facility

MYRON T. LA DUC[1], MICHAEL KEMPF[1], WAYNE NICHOLSON[2], ROGER KERN[1], AND KASTHURI VENKATESWARAN[1]

[1]Biotechnology and Planetary Protection Group, NASA Jet Propulsion Laboratory
California Institute of Technology, Pasadena, CA 91109
[2]Department of Veterinary Science and Microbiology, University of Arizona, Tucson, AZ 85721

Characterizing the microbial communities on surfaces of spacecraft and their assembly facilities is crucial in monitoring the cleanliness of these pseudo-sterile, oligotrophic environments. Here, we present the results of a study in which surface samples, retrieved from the Mars Odyssey Spacecraft and the Kennedy Space Center Spacecraft Assembly and Encapsulation Facility II (SAEF-II), were characterized by molecular and traditional, culture-based methods. Isolates cultivated from either the spacecraft or facility were screened for environmental resistances by challenging with treatments of γ-radiation, UV, H_2O_2, and desiccation. The findings of this study improve our current understanding of the microbial community structure, diversity, and survival capabilities of microbes in a spacecraft assembly facility, and physically associated with co-located spacecraft. Surfaces of the spacecraft (25 cm^2) or facility (0.4 m^2) were sampled and examined for total heterotrophs. In addition, samples were subjected to DNA extraction, and rDNA fragments were PCR amplified and cloned. Population dynamics remained fairly consistent between the spacecraft and assembly facility clone libraries. Predominant microbes, by molecular methods, included species of *Variovorax, Ralstonia,* and *Aquaspirillum.* Culture-based techniques found species of *Bacillus* to be dominant, sharing such habitat with comamonads, microbacteria, and Actinomycetales. Several isolates showed resistances to one or more challenges. Surprisingly, one Gram-negative isolate (*Acinetobacter radioresistens),* swabbed directly from the spacecraft was found to survive an appreciable dose of γ-radiation (>1 Mrad). Several spore-forming isolates were found to possess a plethora of resistances, as these samples were resistant to γ-radiation, UV, H2O2, and desiccation. Our findings validate the purpose of planetary protection activities, which improve our knowledge of the types of microbial burden present, the survival capabilities present therein, and the methods by which microbes gain entry into spacecraft assembly facilities.